Evaluation of Heart Rate Reserve and Exercise Capacity in Individuals With and Without Metabolic Syndrome in Isfahan

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Abstract

Introduction: Heart rate progressively increases with exercise through the function of sympathetic and parasympathetic nerves. These nerves control the performance of sinoatrial node. Lack of heart rate increase proportionate to the exercise is associated with poor prognosis. Moreover, exercise capacity (EC) is considered as a predictor of cardiac events. The current study compares these two indices in individuals with and without metabolic syndrome in Isfahan.

Methods: The study was performed on 203 people without metabolic syndrome and 123 patients with metabolic syndrome registered in the Isfahan Cohort Study. The demographic data, abdominal circumference, blood pressure, height, and weight of the participants were recorded. Moreover, the serum triglyceride, fasting blood sugar, total cholesterol, high density lipoprotein (HDL), and low density lipoprotein (LDL)levels were measured. Exercise test was carried out according to the Bruce standard protocol and heart rate reserve (HRR) and exercise capacity (EC) were determined and recorded. The age-adjusted data were analyzed using SPSS software, version 15, by the generalized linear model.

Findings: The two groups were not significantly different with regard to HRR (p= 0.27). The level of EC in the metabolic syndrome group was significantly lower than that observed in the group without metabolic syndrome (p= 0.022).

Conclusion: We could not find relationship between HRR and metabolic syndrome or lack of the syndrome. However, the relationship between metabolic syndrome and the EC level indicates that in individuals with metabolic syndrome, when EC decreased, HRR did not change significantly. ***(Iranian Heart Journal 2012; 13(2):40-48).***

Keywords: Metabolic syndrome■ Exercise test■ Heart rate reserve■ Insulin resistance.

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Introduction

In 1988, Reaven et al. introduced metabolic syndrome as a set of risk factors, basically include insulin resistance, hypertension (HTN), dyslipidemia, and other metabolic disorders, which increase the risk of cardiovascular diseases (1). Therefore, scientists all around the world focused on identification of the syndrome to prevent, treat, and lower the risk of cardiovascular diseases (2, 3). In patients with metabolic syndrome, exercise test is helpful in early diagnosis of cardiovascular diseases and also prediction of the risk of mortality and occurrence of cardiovascular events (4-6). Exercise test is an affordable, low-risk method, which provides valuable information for physicians. Two important indices of heart rate reserve (HRR) and exercise capacity (EC) are among the findings of the test. HRR is defined as the increase in the heart rate occurred with increase in activity. If the value of HRR is not above 85%, it is considered to be normal and desirable. The value below 85% is associated with poor prognosis (7-10).

EC is the maximal activity an individual can do during the exercise test, which is reported in metabolic equivalents (METs). One unit of MET is equivalent to the activity during which 3.5 ml of oxygen is consumed per each kilogram of the body weight, and is measured in metabolic unit (METs) in each minute. According to the studies, these two indices are strong predictors for the risk of mortality of cardiovascular diseases (11-17). However, all patients with metabolic syndrome are not at the same risk for development of cardiovascular diseases, and several factors including race, life style, and health culture are effective in this respect (18-19). In different studies, researchers obtained different results regarding these factors (20-26). Furthermore, various interventional approaches have different effectiveness in reducing the disease risk (27-29). It was mentioned that metabolic syndrome plays an important role in development of cardiovascular diseases, which is a major cause of death among adults in our country. Moreover, prevalence of metabolic syndrome is very high in the population under study, and the population has differences in ethical and climate conditions with other populations studied in other countries (30-32). Therefore, in the current study, we evaluated the HRR and EC of patients with metabolic syndrome and compared the values obtained with those of the individuals without the syndrome.

Methods

This cross-sectional study was carried out on 203 individuals without metabolic syndrome and 123 individuals with metabolic syndrome who were registered in the Isfahan Cohort Study. Isfahan Cohort Study is a prospective cohort study, which was started in 2002 and will continue until 2012. In the cohort study, using multi-stage cluster sampling, people with ages above 34 from Isfahan, Najafabad, and Arak were selected. All the demographic and behavioral data, as well as the indices such as blood pressure, body mass index, and the results of routine blood tests were recorded for all participants in the first year of the study. In the following, with two-year intervals, the occurrence of cardiac infarction, stroke, sudden death, and hospitalization were asked via telephone calls. Then, in the fifth

and sixth years of the follow-up, clinical examinations and routine blood tests were performed. Further details were published by Sarafzadegan et al. in 2003 (33). In October 2009, 260 individuals with metabolic syndrome and 260 individuals without metabolic syndrome from the study population of Isfahan Cohort Study who met the inclusion criteria of the current study were selected using accessibility sampling method. Using the telephone number of the participants in their file, they were invited to participate in the study. Only 123 individuals with metabolic syndrome and 203individuals without the syndrome participated in all steps of the study and other were excluded from the study because of not cooperating in fulfillment of the study steps. They were invited to the Isfahan Cardiovascular Research Center according to an appropriate schedule. The participants attended an interview and the objectives and methodology of the study were explained for them, and then after signing a written consent, they were included in the study. The inclusion criteria for those with metabolic syndrome were being affected by the syndrome according to the protocol of the National Cholesterol Education Program/ Adult Treatment Panel (NCEP/ ATPIII). In this respect, the individuals having three or more of the following items were considered to have metabolic syndrome:

1- Waist circumference above 102 cm in men and above 88 cm in women,
2- Blood triglyceride (TG) level ≥ 150 mg/dl,
3- Fasting blood sugar (FBS)≥ 110 mg/dl,
4- High density lipoprotein (HDL) level ≤ 40 mg/dl in men and ≤ 50 mg/dl in women, and
5- Systolic blood pressure (SBP) ≥ 135 mmHg or diastolic blood pressure (DBP) ≥ 85 mmHg (34).

The control group members were also selected from the same population in the Isfahan Cohort Study, and were included after matching for gender, age, and not being affected by metabolic syndrome. The exclusion criteria were 1- not being able to perform the exercise test; 2- presence of an absolute contraindication for performance of exercise test, for instance myocardial infarction in the recent two days, advanced heart block, acute pulmonary emboli, uncontrolled hypertension, acute myocarditis, severe aortic valve stenosis, or uncompensated cardiac failure; 3- pregnancy; and 4- not being willing to attend the study (4). The participants referred to the Isfahan Cardiovascular Research Center for the examinations at 12-hour fasting state. After carrying out general physical examination and blood sampling, the waist circumference, blood pressure, weight, and height were measured according to the international standards (35). The TG and total cholesterol (TC) levels were determined using the enzymatic method by Autoanalyzer Hitachi 902. Moreover, HDL level was measured using heparin-magnesium precipitation method (36), and LDL level was calculated according to the Friedewaldformula (37). If the TG level was above 400 mg/dl, the LDL level was directly measured using a specific kit. The FBS level was determined using the enzymatic method of glucose oxidase. The 12-lead electrocardiogram (ECG) was taken by a

trained technician, and the ECG was interpreted according to Monica protocol (38). Then, exercise test was carried out according to Bruce or modified Bruce method, and the HRR and EC values were determined and recorded in the participants' files.

The data obtained wereadjusted for age and then analyzed by SPSS software, version 15, using the generalized linear model. The p value < 0.05 was considered to be statistically significant.

The definitions used in the study were as follows:

Hypercholesterolemia: TC> 200 mg/dl when using cholesterol lowering agents.

Hypertriglyceridemia: TG> 200 mg/dl when using TG lowering agents.

Dyslipidemia: Presence of hypercholesterolemia or hypertriglyceridemia or decreased HDL-C.

Diabetes: FBS> 126 mg/dl when taking anti-diabetic drugs.

Hypertension: SBP> 140 mmHg or DBP> 90 mmHg when taking at least one anti-hypertensive drug.

Findings

In total, 326 individuals participated in the study, among which 56 men and 67 women had metabolic syndrome, and 122 men and 81 women did not have metabolic syndrome. The youngest and oldest participants were at the age of 35 and 82, respectively. The mean age of those with and without metabolic syndrome were 54.29 and 54.16 years, respectively.

The values obtained in the examinations for weight, waist circumference, SBP, DBP, the laboratory findings with regard to the gender, and also having metabolic syndrome or not, were adjusted by age and provided in Table 1. The frequency rates of dyslipidemia, diabetes, and hypertension in the group with metabolic syndrome were higher than those in the group without metabolic syndrome (Table 2).

With regard to the indices of the exercise test, the HRR values in the group without metabolic syndrome were 75.09% and 73.17% in men and women, respectively. The values in the group with metabolic syndrome were 73.52% and 73.13%, respectively. The two groups were not significantly different in this respect (P value= 0.27) (Table 3).

The mean EC levels in the groups with and without metabolic syndrome were determined to be 7.56 and 9.3 METs, respectively. The difference between the two groups in this respect was statistically significant (Table 3). In both groups, the EC level in men was higher than that in women, and the difference observed between men and women in each group was statistically significant (Table 3).

Table 1: Mean comparison of biochemical and clinical indices in individuals with and without metabolic syndrome.

	Without metabolic syndrome	With metabolic syndrome	P value
Age (years)	54.1626±8.61947	54.2927±7.60471	0.89
Waist circumference (cm)	87.9680±9.43267	98.4179±8.74520	<0.001
Weight (Kg)	70.103±11.0853	80.350±12.8479	<0.001
Triglyceride (mg/dl)	140.38±61.657	259.99±184.498	<0.001
Total cholesterol (mg/dl)	201.17±35.788	217.34±49.596	0.003
HDL (mg/dl)	47.91±11.622	41.77±8.674	<0.001
LDL (mg/dl)	116.17±24.049	120.12±29.551	0.21
FBS (mg/dl)	81.81±9.902	107.13±48.465	<0.001
Mean SBP (mmHg)	116.0653±13.69802	130.7378±15.15577	<0.001
Mean DBP (mmHg)	76.5271±6.69518	82.8455±8.70495	<0.001

Table 2: Relative frequency of diabetes, dyslipidemia, and hypertension with regard to the gender and having or not having metabolic syndrome.

	Dyslipidemia	Diabetes	Hypertension
Men with metabolic syndrome	91.10%	32.10%	50%
Men without metabolic syndrome	63.90%	1.60%	9%
P value	<0.001	<0.001	<0.001
Women with metabolic syndrome	89.60%	28.40%	32.80%
Women without metabolic syndrome	63%	1.20%	11.10%
P value	<0.001	<0.001	<0.001

Table 3: Mean comparison of HRR and EC in the groups with and without metabolic syndrome.

	HRR	EC (METs)
Men without metabolic syndrome	70.09%±7.571%	10.25±10.4
Women without metabolic syndrome	73.17%±7.601	7.5±1.9
P value	0.079	0.022
Men with metabolic syndrome	73.52%±7.685%	8.87±2.3
Women with metabolic syndrome	73.13%±9.21%	6.7±1.9
P value	0.805	0.001
P value between the two groups	0.27	0.022
Individuals with metabolic syndrome	73.31%±8.522%	_
Individuals without metabolic syndrome	74.33%±7.622%	_

Discussion

In the current study, we evaluated two important factors for prediction of the risk of cardiovascular diseases; namely HRR and EC, in individuals with and without metabolic syndrome who attended the Isfahan Cohort Study.

In the study, it was observed that the two groups were not significantly different in the HRR value (p value= 0.27). Moreover, the HRR values in men and women of each group were not significantly different (p values: 0.07 and 0.85 for those with and without metabolic syndrome, respectively).

By reviewing the literature, Regitz-Zagrosek has stated the impact of gender differences is not definitely confirmed on the prognosis of metabolic syndrome (32).

Moreover, in a review paper, Arena reported that the impact of gender differences on HRR in normal people is not definitely defined (34). Nilsson stated that HRR is lower only in women with metabolic syndrome (35).

Exercise Capacity is one of the most important prognostic in Exercise test .in patients with khnown or suspected CAD,a limited exercise capacity is associated with an increased risk of cardiac events. And in general ,the more severe the limitation ,the worse the CAD extent and prognosis.7

Mora and associates have reported that atter adjustment for framing ham Risk score low peak METS was significant predictor of cardiovascular death .

Serial comparison of functional capacity in individual patients to assess significant interval change reguires a carful examination of the exercise protocol used during both tests,drug therapy and time of ingestion ,systemic blood pressure ,and other conditions that might influence test performance all those variables need to be considered before attributing changes in functional capacity to progression of CAD or worsening of left ventvicular function . major reductions in exercise capacity usually indicate significant worsening of cardiovascular status modest changes may not(10)

In selected patients with severe left ventricular dysfunction and symptomatic heart failure coronary byposs surjery is associated with significant increase in exercise capacity when alarje amount of dysfunctional but viable myocardium (more than 25%of left ventricular moss) is revascularized.

In the current study, the EC values were 7.56 and 9.3 METs in participants with and without metabolic syndrome, respectively (p= 0.022). Furthermore, in both groups, the EC levels weresignificantly lower in women. Considering the EC levelin different studies on various populations, the EC level have been proposed as a strong predicting factor for both genders (9- 17).

The most notable result of the study is the similar values of HRR in individuals with and without metabolic syndrome. Also, since the Isfahan Cohort Study is in progress, the predicting values of HRR in the population under study could be determined by evaluation of the rate of cardiovascular events in future.

In the study, it was demonstrated that the EC level in the groups with metabolic syndrome was significantly lower than that in people without the syndrome (p= 0.022). This is consistent with the findings of previous studies. Therefore, it can be concluded that in the population under study, the

relationship between EC and metabolic syndrome is stronger than that for the HRR. This would be useful for physicians and health planners in making more accurate decisions.

Moreover, the study could serve as a foundation for further studies in our community on people with metabolic syndrome, the relationship between the syndrome and cardiovascular diseases, and alsothe predicting value of the above-mentioned indices.

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